

# **Theme 2: Modeling, Data Assimilation and Advanced Computing**

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**Forecast Uncertainty:  
Ensembles, statistical post-processing, and decision support**



# Uncertainty in Weather Forecasts

- All weather forecasts are uncertain, some more than others
- Today's NWS forecasts are mostly deterministic, e.g.,  $T_{max} = 70^{\circ}F$ 
  - Exceptions: PoP, hurricane graphics
- Quantitative expression of uncertainty is required to “*complete the forecast*”
  - e.g.,  $P(67^{\circ} < T_{max} < 72^{\circ}) = 80\%$



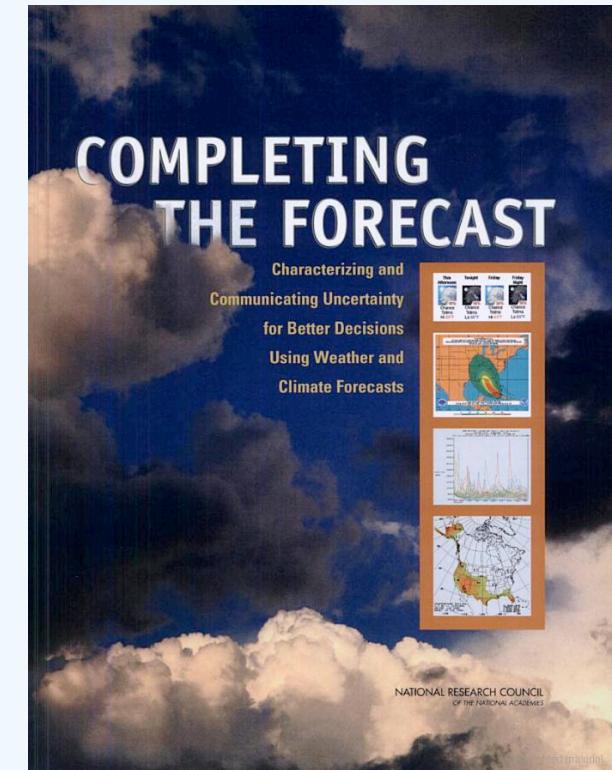
uncertainty associated with forecasts from 3 initial states on Lorenz '63 attractor.  
c/o Tim Palmer, ECMWF





# NWS takes action, ESRL is there

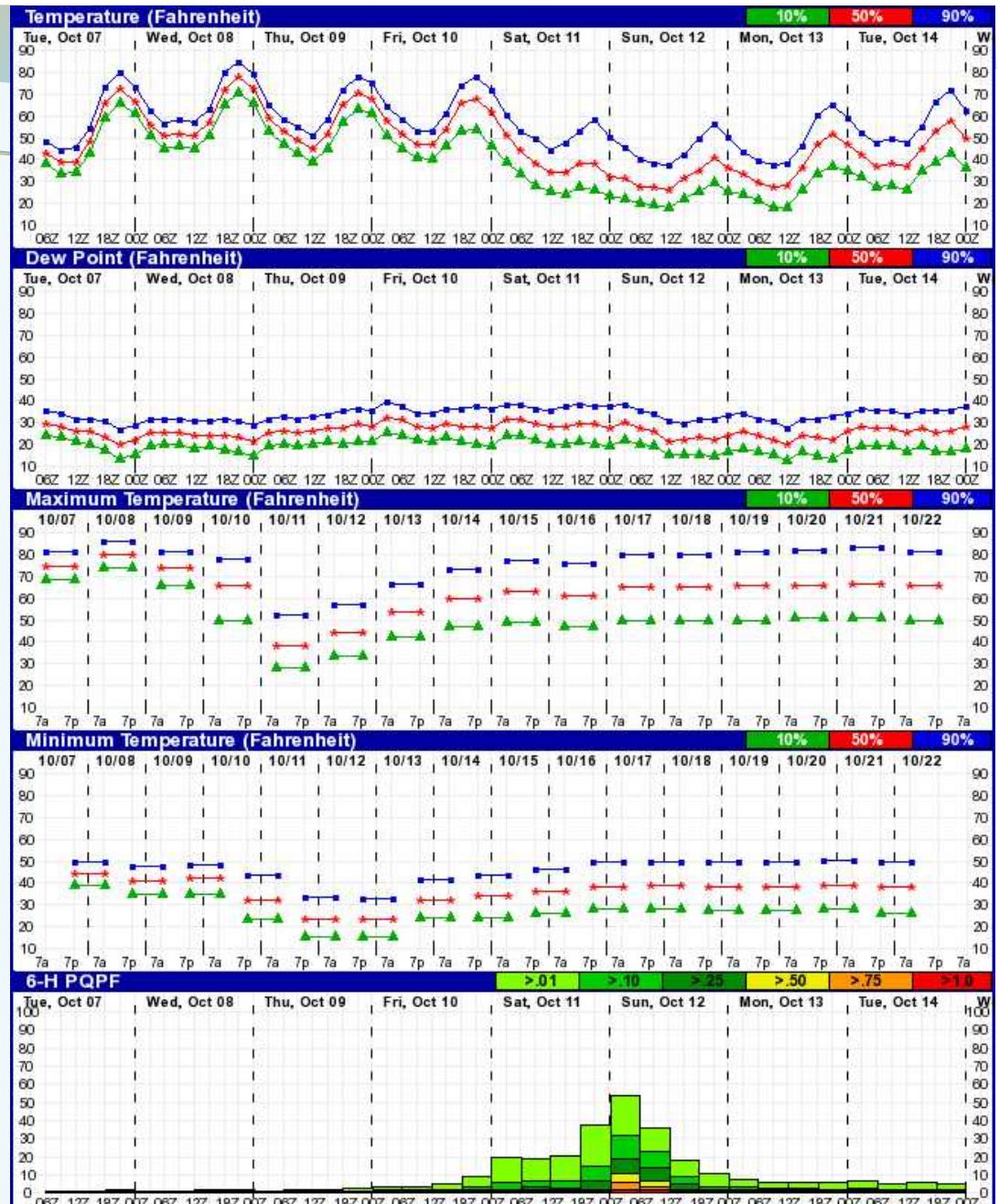
- 2006 NRC report: *Completing the Forecast*  
Characterizing and Communicating Uncertainty for Better Decisions Using Weather and Climate Forecasts
- NWS Forecast Uncertainty Program
  - Requirements research
    - Ensemble workshops (Toth)
    - AMS Committee on Uncertainty in Forecasts (Hamill, Schultz, Toth)
      - *Important report coming soon!*
  - AWIPS prototypes (Schultz)
    - Ensemble browsing
    - Probabilistic forecasting
  - Role of the forecaster
    - Two workshops here at DSRC
- New products and services





# Probabilities

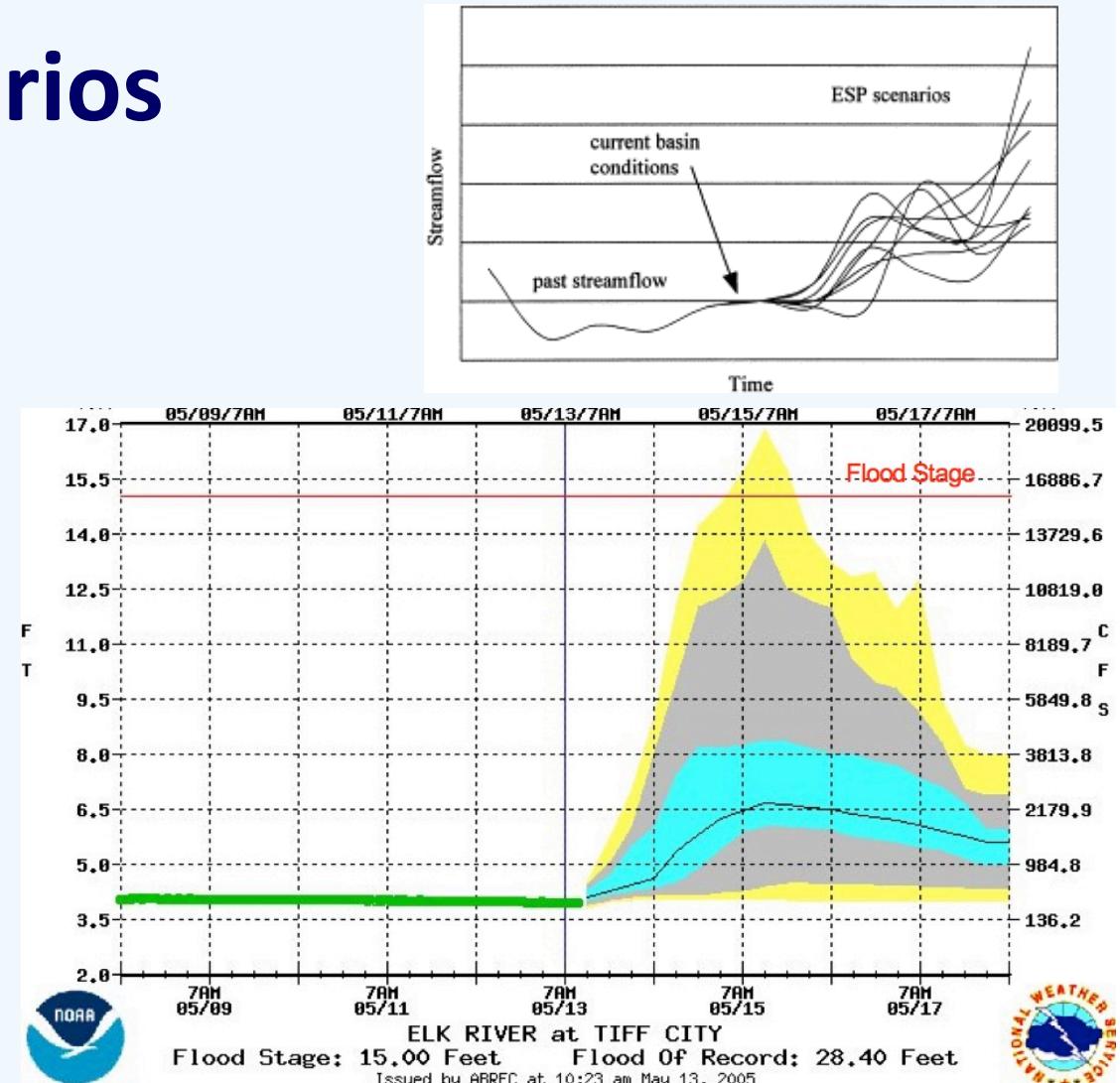
- 10/50/90 expression for temperature, dewpoint
  - Proposed at NCEP workshops
  - Vetted by NWS forecasters at ESRL workshops
- PQPF
- All on NDFD grid (2.5 km CONUS)





# Multiple Scenarios

- Some users want to see the *effects* of weather forecast uncertainty in their decision support modules
  - Hydrology: family of hydrographs
  - Aviation: aircraft routing alternatives
- Bias-corrected ensemble members
  - NAEFS
  - ESRL/NCEP partnership





# Decision Support by Forecasters

- Expanding on 100+ years of NWS tradition
  - IMET, Spot forecast program (forest fires, conventions)
    - Thin clients, smart phones
    - GoToMeeting support for airports, media, state DoT's
- Probabilities and alternative scenarios inform forecasters
  - AWIPS tools developed by GSD
  - Forecaster workshops conducted at DSRC





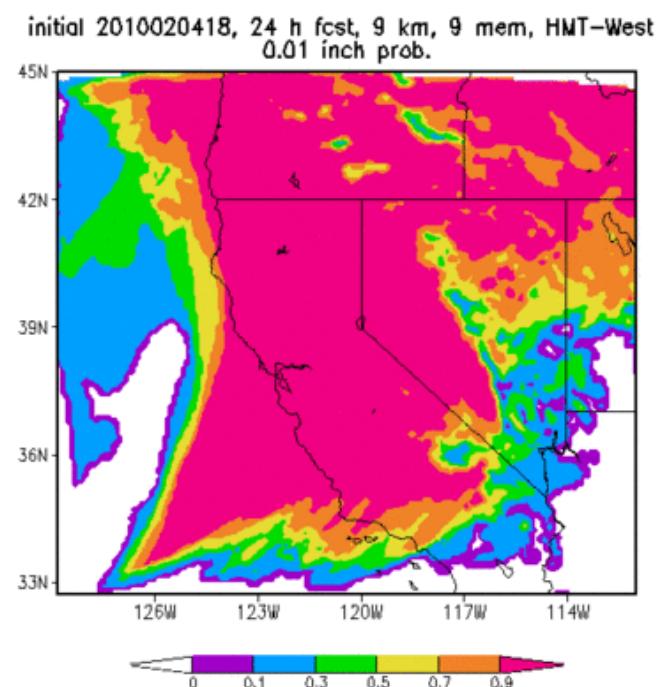
# Ensemble numerical weather prediction is critical to all three!





# Ensemble Research at ESRL, p1

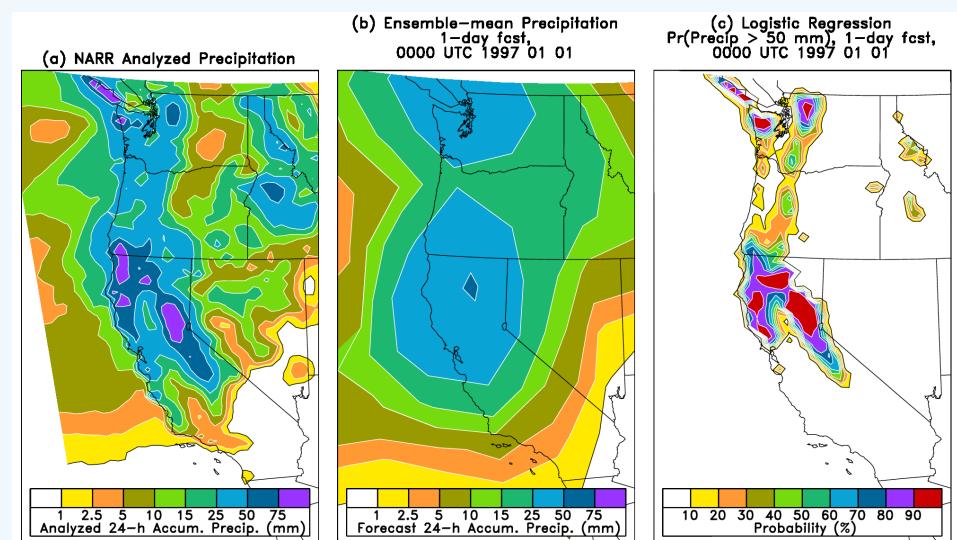
- Hydrometeorological Testbed
  - Supplemental forecasts for West Coast
  - Cloud-system resolving ensemble
  - PQPF
- NAEFS multiple scenarios
  - Based on US, Canadian ensembles
  - Bias corrected and downscaled to NDFD
- Experimental products for aviation (NextGen)
  - Probabilistic convection forecasts





# Ensemble Research at ESRL, p2

- GFS reforecasts (see poster)
  - Improved treatment of rare events
  - *Operational at NCEP*
- Ensemble Kalman filter
  - Initializing ensembles
  - Improvements to 4DVAR
    - Collaboration with EMC
- Parameterizing model uncertainty
  - Spread correction in ensemble forecasts
- Stochastic physics experiments





# ESRL Forecast Uncertainty Activities with NWS

- AWIPS developments
  - Ensemble manipulation, weighting, visualization
- NWS workshops:  
forecasters + AWIPS developers
  - Probabilistic forecasting, Oct 08
  - Communicating uncertainty and decision support, Aug 09
  - Next-generation tactical weather info technology, Oct 09
- Personal Weather Advisor (*see electronic poster*)
  - Web-based decision support tool prototype
  - Interface to NWS probabilistic forecasts





# End

